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Master Thesis

"The Effect of Corporate Venture Capital Investments on the Investor's Innovativeness: The Moderating Role of Geographic Proximity and Investment Stage"

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Abstract

Drawing upon the knowledge-based view theory, knowledge can be considered the most important strategic resource for companies and the foundation for innovation and growth. However, especially incumbents struggle to create new innovations internally and thus, increasingly search for tools to source external knowledge for the firm. Corporate venture capital (CVC) investments are one way to access new knowledge, capabilities and technologies to drive innovation within companies. Using a panel dataset of 66 individual corporate investors with more than 400 observations, this paper explores the impact of CVC deals on the investor's innovativeness and investigates circumstances influencing the relationship. This research finds a positive relationship between corporate venture capital deals and the investor's innovativeness, measured by patent applications. Furthermore, this study finds empirical evidence that the relationship between CVC deals and the corporate investor's innovativeness is stronger when investors invest in startups in an early development stage, as their knowledge is more disruptive and valuable for the incumbent. Last, this paper does not find a significant moderating effect of geographic proximity on the relationship between corporate venture capital and innovation. The spatial distance of an investment does not seem to be a crucial determinant for the success of corporate venture capital deals, supporting the arguments of authors proclaiming a "death of geography".

Keywords: knowledge-based view theory, corporate entrepreneurship, real options theory, corporate venture capital, innovation, investment stage, geographic proximity, death of geography

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1. Introduction

Recent trends such as digitalization, rapid technological change, increasing levels of competition and correspondingly shorter product life cycles threaten existing market positions of incumbent firms. As a response to these trends, companies realize that creating a continuous stream of innovations is essential to stay profitable and to maintain a competitive advantage (Artz et al., 2010). Joseph Schumpeter (1934) argues that firms have to innovate to survive and to be successful in the long run. He highlights that if incumbents are not able to adjust their business models to changes in the environment, there is a high chance that they will be replaced by disruptive new entrants.

Furthermore, Henderson (1993) outlines that especially large and established firms face difficulties to generate new innovations internally. Innovations can be defined as "new combinations of new or existing knowledge, resources, equipment, and other factors" (Schumpeter, 1934, p.65) with the attempt to commercialize it. The reason many incumbents fail to internally create innovations is that they lack dynamic capabilities and struggle to adapt to changes in technologies and markets (Henderson, 1993). Moreover, Tidd and Bessant (2009) argue that incumbents, which often have bureaucratic structures, do not possess the entrepreneurial spirit to foster radical innovation and that these structural deficiencies hamper the innovation process. To compensate, incumbents do not only seek to create new knowledge through research and development (R&D) but also search for new knowledge or technologies from outside the boundaries of the firm (Caloghirou, Kastelli & Tsakanikas, 2004).

This draws upon the knowledge-based view (KBV) theory, which deems knowledge to be the most important strategic resource for companies and the foundation for a competitive advantage (Grant, 1996; Kohlbacher, 2007; Curado & Bontis, 2006). The KBV theory can be regarded as an extension of the resource-based view, considering knowledge as a special resource that does not depreciate but accumulates over time, contrarily to other economic productive factors (Curado & Bontis, 2006). Today, there is common ground in the literature that knowledge is an important driver to create innovation and to stimulate economic growth (Howells, 2002). The KBV theory and Schumpeter's thoughts outlined above, demonstrate the importance of knowledge and innovation for large corporations and that gathering and using new sources of knowledge should be deeply ingrained in a company's strategy.

There are generally two ways for corporations to source new knowledge and to develop new capabilities, serving as a prerequisite for innovation. In particular, knowledge can be created internally through R&D initiatives or can be externally acquired and incorporated into the innovation units of the firms. Access to external knowledge usually occurs through three different means: strategic alliances such as joint ventures, joint development agreements or technology-sharing initiatives, mergers & acquisitions (M&A) or corporate venture capital investments (De Man & Duysters, 2005). This paper sheds light on the impact of CVC investments on the investor's innovativeness and examines two factors influencing the strength of the relationship. The other two means, strategic alliances and M&A, are not in the scope of the study.

Corporate venture capital can be defined as "equity investment by incumbent firms in independent entrepreneurial ventures, i.e., relatively new, not-publicly-traded companies that are seeking capital to continue operation" (Dushnitsky & Lenox, 2005, p. 615). A fundamental difference between independent venture capital (IVC) and CVC is the purpose of the investment. While IVC firms primarily target positive financial returns, CVC investors are additionally looking for strategic benefits to the parent company (Dushnitsky & Lenox, 2006). This is the reason why CVC investments possess on average longer investment durations than IVC investments (Guo, Lou & Perez-Castrillo, 2015). In surveys, corporate managers were asked to rank the primary objectives for investing CVC in startups. The survey revealed that the ability to gain knowledge about new technologies and markets was ranked highest among all proposed goals (Alter & Buschbaum, 2000).

Furthermore, Amin and Wilkenson (1999) argue that there is a "rediscovery of competences as determinants of economic performance" (p.121). Social scientists realize that a central element to determine the long-term success of incumbents is the firm's ability to generate and secure knowledge and to continuously learn. One significant aspect of organizations' competences to be successful is the ability to access and incorporate externally derived knowledge. However, for a long time in research, there has been a debate on whether internally generated knowledge through R&D is sufficient for companies to successfully innovate or whether internal firm knowledge should be paired with external knowledge from e.g. startup companies (Sahaym, Steensma & Barden, 2010). These authors argue that there is a complementary effect between R&D and CVC, stating that the more R&D spending, the more CVC investments because companies better realize the potential of exploiting the investments and that the interplay between both significantly improves innovation performance. This is in line with open innovation literature. Chesbrough (2003) recognizes a shift from internal knowledge creation or closed systems of innovation towards more open systems, in which multiple participants engage collaboratively in innovation. In an open system, firms incorporate both internal and external knowledge to drive innovation and to maximize value for the firm.

First, this paper elaborates on the overarching problem statement of this research and introduces the corresponding research questions. Second, existing literature is reviewed and hypotheses are derived from the theory. Third, the methodology to test the hypotheses is outlined, including the data collection process, the research method and the research design. Fourth, results from the multivariate analysis are presented. Last, this paper concludes with a discussion and managerial implications and highlights some limitations of the empirical study.

2. Problem Statement and Research Questions

With a compounded annual growth rate (CAGR) of 21.64% in global CVC deals and a global CVC investment funding CAGR of 37.97% over the last 5 years, CVC is becoming increasingly important to many firms as a source of knowledge to foster innovation (see Figure 1). Global CVC activity even accelerated to an all-time high in 2018, emphasizing that CVC investments become more and more part of corporate strategies.

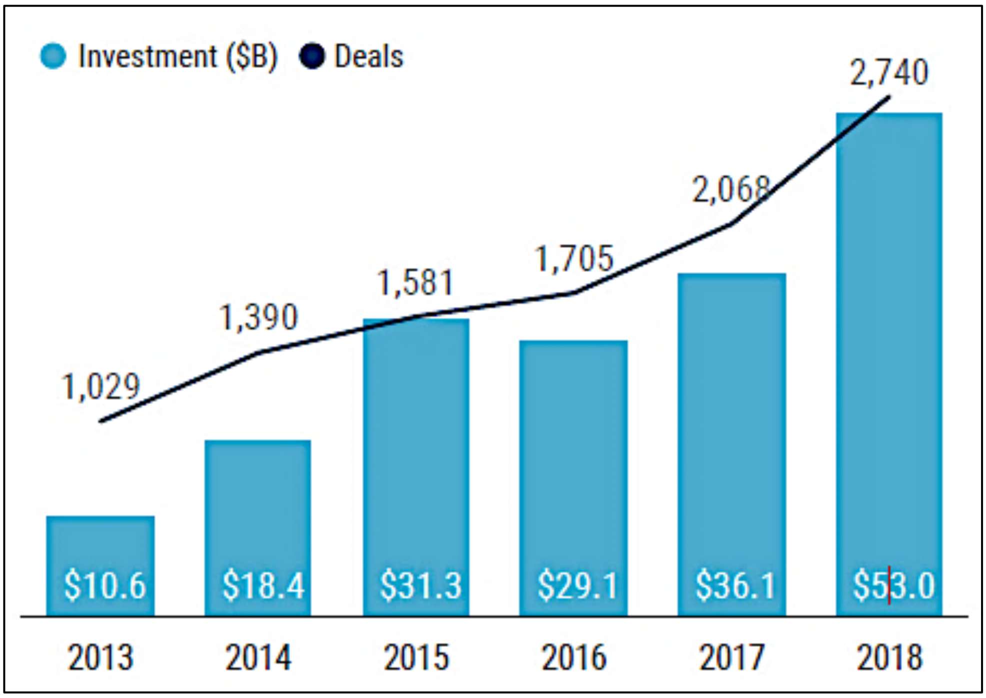

Figure 1 – Annual global disclosed CVC deals and funding, 2013 –2018. From "The 2018 Global CVC Report" by CBInsights (2019)

The ability of firms to use and develop innovative capabilities is nowadays commonly recognized as one of the most crucial determinants for firm performance and competitive advantage (Helfat & Peteraf, 2003). However, CVC is a relatively new and emerging phenomenon, which becomes increasingly important to large corporations around the world as shown in the graph (see figure 1) above.

Due to this growing recognition, CVC investments receive more and more attention in the empirical literature as external knowledge sourcing vehicle (Dushnitsky & Lenox, 2005). However, the research field of corporate venture capital is still less examined than that of IVC as well as other tools to gather knowledge for firms. So far, many studies focused on finding empirical evidence for external knowledge acquisition means such as joint ventures, mergers & acquisitions and strategic alliances (Hagedoorn & Duysters, 2002; De Man & Duysters, 2005). This research attempts to fill this gap in empirical literature by investigating CVC investments as a tool for external knowledge acquisition for companies. Therefore, the following problem statement is examined in this paper:

Problem Statement: *What is the impact of corporate venture capital deals on the innovativeness of the investor?*

Although research about corporate venture capital is growing, the understanding of circumstances that influence the relationship between CVC and the investor's innovativeness is lacking consistency and depth. There are mainly three streams of literature that examine moderating factors in the context of CVC and innovation. These areas of research deal with (1) the environment, in which the investment occurs, (2) multiple facets of relatedness and proximity between the investor and the startup company and (3) characteristics and capabilities of the incumbent. More specifically, researchers looked at moderating factors, including (1) weak vs. strong intellectual property environments (Dushnitsky & Lenox, 2005; Dushnitsky & Shaver, 2009), (2) technological, strategic and industrial relatedness (Chemmanur, Loutskina & Tian, 2012; Yang Narayanan, & Zahra, 2009) geographic, organizational and cognitive proximity between the corporate investor and the startup (Howells, 2002; Boschma, 2005, Morgan, 2004; Han, Tsou & Clarke, 2017; Tian, 2010), (3) absorptive capacity capabilities of the incumbent (Dushnitsky & Lenox, 2005; Campo & Ayala, 2012; Cohen & Levinthal, 1990), governance modes (Keil et al., 2008) and preferred investment stages (Matusik & Fitza, 2012; Yang, Narayanan & Zahra, 2009; Keil, Zahra & Maula, 2004; Wadhwa, Phelps & Kotha, 2010).

However, the findings in these areas of research are inconsistent. Especially, literature about geographic proximity is twofold. While Howells (2002) and Morgan (2004) argue that the spatial distance between investors and entrepreneurial ventures should be minimized to ensure and facilitate tacit knowledge spillovers, other authors devalue the impact of geographic locations on knowledge transfer. Han, Tsou & Clarke (2017) argue that through the Internet as a tool of global mass communication, a "death of geography" occurred and that geographic proximity is neither a necessary nor a sufficient condition for knowledge transfer (Boschma, 2005).

Furthermore, existing literature about the optimal investment stage for corporate investors is lacking consistency. Wadhwa, Phelps and Kotha (2010) argue that the later a corporate investor invests, the easier is the knowledge transfer, as startups have a much better understanding of their businesses and technologies. Contrarily, Chesbrough & Tucci (2002) highlight that early stage ventures provide investors with more groundbreaking information about new technologies from the market. Although early stage investments are characterized by more uncertainty and a higher level of risk, the authors emphasize that knowledge at this stage is more disruptive and offers more radical opportunities to the incumbent.

This study sheds light on the problem statement outlined above and the controversies with regards to the optimal investment stage and the geographic proximity between corporate investors and startups and investigates the following three research questions:

Research Question I: *To what extent do corporate venture capital investments of incumbents enhance the innovativeness of the investor?*

Research Question II: *How does the geographic proximity between the corporate investor and the investment target influence the relationship between corporate venture capital investments and the investor's innovativeness?*

Research Question III: *How does the investment stage influence the relationship between corporate venture capital investments and the investor's innovativeness?*

This study makes several contributions to the existing literature. First, this research extends the corporate entrepreneurship literature by examining the effect of CVC investments on the innovativeness of the investing firm. Furthermore, this paper explores different circumstances shaping this relationship and sheds light on contradicting streams of the literature regarding moderating factors. Second, the knowledge-based view literature is augmented by analyzing the effect of external knowledge acquisition on the investor's innovation activities in the context of CVC and by investigating the role of geographic proximity as a facilitator for tacit knowledge spillovers. Third, this study contributes to the real options theory by exploring the effect of investment stages as a factor, influencing the relationship between CVC and the investor's innovativeness. Finally, this research provides practitioners with managerial guidance on what to consider when investing capital in startup companies.

3. Theoretical Background and Hypotheses

Existing challenges of our time force incumbents to rethink their business models and innovation strategies. This chapter incorporates different streams of literature and introduces existing theory with regard to CVC and its impact on the investor's innovativeness. Moreover, the reasoning of geographic proximity and investment stage as moderating variables are examined. From this theory, three hypotheses are drawn.

3.1 Corporate venture capital and innovation

As corporate venture capital becomes increasingly important to many incumbents around the world, the academic interest in this subject has risen. Drawing upon the knowledge-based view theory, knowledge is considered to be the most important strategic resource for companies, as it strengthens a firm's market position and can lead to a competitive advantage (Grant, 1996). However, Kogut and Zander (1992) argue that to be able to sustain the competitive advantage, knowledge has to be constantly extended and renewed. Henderson (1993) outlines that an incumbent's capability to internally develop new knowledge is limited. He argues that purely relying on R&D as the main source of innovation is not sufficient in today's dynamic world to maintain its competitive position. Therefore, companies should look outside the boundaries of the firm in order to find additional sources of radical knowledge (Cohen & Levinthal, 1990). CVC is one promising source and opportunity to access new knowledge and to learn from entrepreneurial ventures (Keil, Zahra & Maula, 2004). Entrepreneurs often actively seek corporate investors as strong partners because they benefit from funding, value-added services and access to additional product markets (Dushnitsky & Lenox, 2005). In return, ventures are willing to grant access to their operations, technologies and specialized know-how. Thus, the authors describe corporate venture capital as a "useful learning investment strategy" (Lee & Kang, 2015, p.349) to create more technological options for the future.

Dushnitsky and Lenox (2005) identify three ways of how new knowledge is transferred from the venture into the firm and how interorganizational learning is created through CVC. First, before funding a venture, investors generally conduct due diligences of a startup's operations and business plan. This procedure involves background checks of the founders, reviews of the product and services as well as conversations with consumers. For this process, executives call on the help of R&D departments, which support in evaluating technologies, market risk and business potential. This knowledge gathering and exchanging approach leads to more dedication and awareness for future technologies as well as to better communication and cooperation within the company (Chesbrough, 2002). Therefore, this procedure is an enormous opportunity for the incumbent to learn even before the capital commitment. Second, firms learn from entrepreneurial ventures after the investment has taken place. It is common in the startup ecosystem that corporate investors occupy board seats in the invested firms, which provide managers with additional insights and knowledge about the venture and its technologies from within the firm. Furthermore, incumbents start establishing business functions in their corporations to ensure continuous knowledge exchange between investor and venture. Last, incumbents learn from the failing of ventures. Even startup failures provide investors with profound knowledge and learnings about technologies and markets that should not be further pursued (Dushnitsky & Lenox, 2005).

Research shows that CVC does not only yield superior financial performance (Dushnitsky & Lenox, 2006) but also leads to better strategic decisions (Wadhwa & Kotha, 2006). Scholars found multiple reasons why this is the case. First, corporate investors gain new insights about recent technology developments from the market (Chesbrough & Tucci, 2002). Startups are usually faster in discovering new and disruptive innovation, which opens a "window on new technologies" (Benson & Zedonis, 2009, p.329) and learning for the company. Corporations can use that information and integrate it into their own innovation system. Second, as Maula, Keil & Zahra (2013) outline, CVC investments can serve as an alert mechanism to detect technological discontinuities. Technological discontinuities are "fundamental shifts from one technology to another" (Maula, Keil & Zahra, 2013, pp. 926-927) and threaten the incumbents' strong market positions. Through the use of CVC, investors become more aware of technological shifts and recognize the need to solve them. Third, the sourcing of external knowledge helps corporations to better exploit internal knowledge creation, as communication, collaboration and interorganizational learning are enhanced (Sahaym, Steensma & Barden, 2010).

Therefore, it seems that incumbents, which invest in startups increase their knowledge stock and improve their innovation activities. It is assumed that the larger the investor's equity investments, the greater the knowledge stock the investor gains access to. There are two ways of how a knowledge base can be extended. It can either grow through investments in a variety of different entrepreneurial ventures or through higher stakes in the individual portfolio companies. The latter provides corporate investors with additional power and consequently, admission to more in-depth knowledge of the startup (Dushnitsky & Lenox, 2005). Moreover, the more knowledge a corporate investor accesses, the more innovation output is generated from a new combination of exisiting knowledge or from entirely new innovative solutions.

From this reasoning, it seems that investments in entrepreneurial ventures are strongly related to superior innovation performance. Therefore, the following hypothesis is drawn:

Hypothesis 1: *There is a positive relationship between corporate venture capital investments and the investor's innovativeness.*

3.2 The moderating role of investment stage

Investing in entrepreneurial ventures is a risky and uncertain commitment. Generally, venture capital literature clusters startups into four development stages, in which firms can invest (Buzzacchi, Scellato & Ughetto, 2015). These four stages include the seed stage, the early stage, the expansion stage and the late stage. According to Matusik & Fitza (2012), investment stages are directly related to different levels of uncertainty. Investing in seed or early stage startups involves much more market and technological uncertainty, compared to investments in the expansion or late stage (Yang, Narayanan & Zahra, 2009; Van de Vrande & Vanhaverbeke, 2012). Sources of uncertainty may include the unawareness of managers or consumers about specific technologies, the missing proof of the startup's technology on the market and a lack of expertise and skills on how to use and apply new technologies.

One financial theory, which is particularly applicable in the context of corporate venture capital and preferred investment stages is the real options theory. As CVC investments in their nature are limited commitments to uncertain technologies with the opportunity to invest further in the future, real options logic can be applied (Sahaym, Steensma & Barden, 2010). Real options represent the value for managers to be flexible in changing or expanding projects based on new conditions. These conditions can be of a technological or economic nature or can result from changes in the market. Kogut & Kulatilaka (2001) describe real options as a marriage of "the theory of financial options to foundational ideas in strategy, organizational theory and complex systems" (p.744). Real options provide managers with the right but not the obligation to undertake different actions in the future (Van de Vrande & Vanhaverbeke, 2012). Therefore, real options help managers to cope with uncertainty and provide them with the privilege to adjust resource commitments if necessary. At the same time, real options decrease downside risk, while preserving upside opportunities. However, with regard to the optimal investment stage for an incumbent, there are two contradicting streams in the empirical literature.

On the one hand, Wadhwa, Phelps and Kotha (2010) argue that the later the investment stage, the better startups know their businesses and technologies. Consequently, the ability to transfer the knowledge from the entrepreneurial venture into the corporate investor firm is facilitated. This is in line with Yang, Narayanan and Zahra (2009), who outline that the performance of entrepreneurial ventures in an early stage is much more difficult to predict. Late stage investments present lower uncertainty because some milestones have already been achieved and technology might have already proven valuable on the market (Matusik & Fitza, 2012). Accordingly, the codification of the knowledge from early stage ventures may be less valuable to the investor than knowledge codified by late stage startups.

On the other hand, to benefit from first-mover advantages, incumbents may invest in startups at a seed and early stage to source radical and disruptive knowledge. Some corporations favor small initial investments in seed and early stage startups with the option to increase the investment in the future (Van de Vrande & Vanhaverbeke, 2012). This is in line with the real options theory outlined above, which suggests that under high uncertainty, corporate investors should make rather small investments. Afterwards, companies can learn from the investments and analyze how to reduce the different levels of uncertainty. When levels of uncertainty decrease, corporations can reevaluate the business opportunity and can either expand the project with a follow up investment or can terminate the commitment. This choice provides managers with additional value, arguing in favor of early stage startup investments. Furthermore, Chesbrough & Tucci (2002) argue that early stage investments provide incumbents with first-hand technology information about potential paradigm shifts that are occurring on the market. Thus, the following hypothesis is subject to further investigation:

Hypothesis 2: *The relationship between corporate venture capital investments and the investor's innovativeness is moderated by investment stage. That is, the earlier the investment stage, the higher the positive effect of the corporate venture capital investments on the investor's innovativeness.*

3.3 The moderating role of geographic proximity

Many firms consider knowledge as a key determinant to innovate and to strengthen competitive position. Polanyi (1966) classifies knowledge into two different types: explicit and tacit knowledge. Knowledge that can be codified and easily transmitted through different communication channels is called explicit knowledge. Tacit knowledge is difficult to formalize and is deeply ingrained in the actions and commitment of a person in a specific context.

Decarolis and Deeds (1999) outline that especially tacit knowledge is often the foundation for a sustained competitive advantage, as it is difficult to imitate and to substitute for competitors or new market entrants. The uniqueness of that knowledge is often unconsciously present in people's behaviors and actions. Thus, it can only be transmitted through experience and interaction. Following this reasoning, incumbents should not only target codifiable knowledge but should specifically look out for tacit knowledge within ventures and incorporate it into the firm. Howells (2002) argues that to ensure positive spillovers for tacit knowledge, the geographic distance between the investor and the startup should be minimized. He outlines that geographic proximity becomes an important factor the more tacit components the knowledge possesses. As tacit knowledge helps to explain codifiable knowledge, the proximity of an investment is a crucial determinant to also facilitate knowledge transfers for explicit knowledge. Additionally, Morgan (2004) provides further evidence against the "death of geography" theory highlighting that geographic proximity plays a significant role to successfully incorporate external knowledge into firms.

Contrarily, Boschma (2005) studied different types of proximity and their impact of knowledge creation and learning. He shows that too much proximity can have negative consequences on learning and innovation due to a lack of openness and flexibility. He argues that geographic proximity is not a key factor determining of whether the transfer of external knowledge successfully leads to innovation, it is more about organizational and cognitive proximity between the firms. Further authors argue in favor of the "death of geography" theory, questioning the importance of geographic proximity (Han, Tsou & Clarke, 2017). Increasing globalization and enhanced technology make the world a smaller place with virtually no borders.

Thus, it is questionable whether the geographic proximity between the investment target and the investor plays an important role in transferring the knowledge into the firm. Up to today, there is no common ground in the empirical literature that shows whether the geographic distance of the corporate venture capital unit to the investment target has an impact on the innovativeness of a firm. Therefore, the following hypothesis is investigated:

Hypothesis 3: *The relationship between corporate venture capital investments and the investor's innovativeness is moderated by geographic proximity. That is, the closer the investor is to the investment receiving firm, the stronger the positive effect of the corporate venture capital investment on the investor's innovativeness.*

3.4 Conceptual model

Following the reasoning from above, a conceptual model has been constructed to summarize the predicted relationships of this research. The different hypotheses and their expected directions are outlined in figure 2 below.

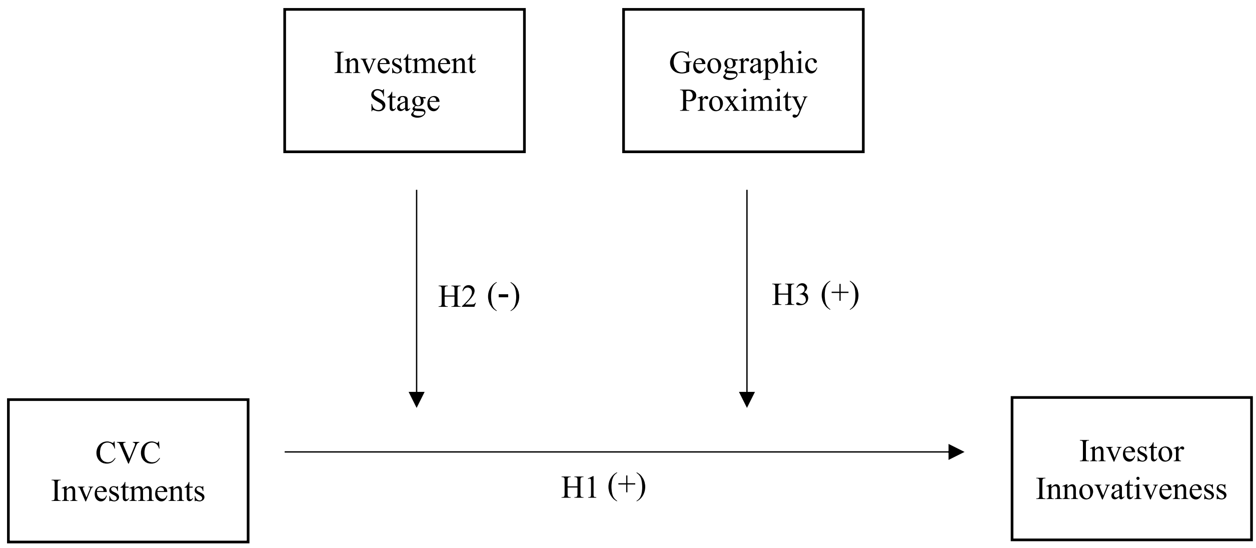

Figure 2 – Conceptual model

4. Research Method

The following chapter elaborates on the research method and the research design implemented to test the proposed relationships. First, the sample and the data collection process are presented. Second, the chapter introduces the measures and variables used to operationalize the concepts. Last, the research design is described, including the procedure, which has been implemented to test the hypotheses.

4.1 Sample and data collection

To test the research questions and hypotheses, panel data were gathered from different sources and combined into one dataset. Panel data incorporate elements of cross-sectional and time-series data, as they measure behaviors of particular entities, in this case, corporate investor units, across time. For the study, data of corporate venture capital deals were collected from Thomson Reuters EIKON database using the PEScreener. After searching the databank for CVC investments, the data were particularly filtered for venture capital deals. Data were retrieved for investments worldwide from 2010-2017. Additionally, the search was extended by using the corporate PE/ venture firm type filter to have a selection of venture capital deals only made by corporate investors. In this data collection round, 9452 deals were identified by 935 individual corporate firms, which invested during this time span. After gathering data from Thomson Reuters EIKON, including startup names, investor names, investment years, sum of equity invested, number of deals, investment stage of the startup firm at the time of the investment and country and continent of the corporate investor and the startup, the data sources were combined in one overarching panel dataset.

As Thomson Reuters' EIKON database only reports investment units of a corporation (example: M12), all units in the dataset were matched with their corporate parent companies (example: Microsoft Corporation). This match was implemented through extensive search engine research for every individual investment unit. In the next step, the parent companies' names were augmented with individual company identifiers, such as the ISIN code (example: US5949181045) and the BvD ID (example: US911144442), the main firm identifier for the Orbis databank. Having incorporated the identifiers of the companies in the dataset, patent data for the years 2011-2018 were retrieved by PatStat, a worldwide patent database, maintained by the European Patent Office. A SQL code was created to facilitate and speed up the search process at PatStat. In the process of cleaning the dataset, pure VC and PE firms as well as other funds, such as pension funds, privately held companies and companies having not much patenting activity were eliminated from the sample. For this analysis, the sample is limited to publicly listed firms, as it ensures accessibility and reliability of financial data. Now, the dataset contains corporate venture capital units having a publicly listed parent company and which have invested in at least 4 of the 9 years of the time span in the sample. After all adjustments, 66 corporate venture capital units are left in the sample, including their investment deals between 2010 and 2017.

Last, CVC and patent data were augmented with additional public data of the parent company, using the BvD ID identifier. Data about total assets, revenue, return on assets and R&D expenditures were collected from Orbis and were also incorporated into the panel dataset.

4.2 Measures

4.2.1 Dependent variable: Innovativeness of the investor

Following the existing literature (Dushnitsky & Lenox, 2005; Seru, 2010; Lerner, Sørensen & Strömberg, 2008), a patent-based metric is used to capture the investor's innovativeness. For a long time in research, patents are argued to be a valid proxy for innovation, as they are unique and are considered to be a visible method to codify knowledge transfer. While other authors use R&D expenditures (Henderson & Cockburn, 1994) or new product announcements (Acs & Auretsch, 1988) as a measure for innovation, this paper uses the number of patent applications per year as an indicator to capture actual innovation output. According to Griliches (1990), patents codify a company's technological knowledge and potential future invention. Patents are a good proxy for innovation because they capture how well a company is able to transform internal and external knowledge combined with other innovation inputs into innovation outputs. The collected panel dataset contains patent application counts from the years 2011-2018 as a dependent variable. However, knowledge creation through CVC does not instantly lead to more patenting activity. This paper uses the approach by Dushnitsky and Lenox (2005) as well as Wadhwa & Kotha (2006) and assumes a one-year time lag between the dependent variable and the independent, control and moderating variables. This one-year time lag accounts for the administrative time between the acquisition of knowledge and the codification of the patent. More specifically, this paper includes each corporate investor (i)'s patenting activity of the year (Y+1) ($PAT_{i,Y+1}$) and compares it with the independent variables in year (Y).

4.2.2 Independent variable: CVC investments

The main independent variable considered in this research is the number of CVC investments by each corporate investor (i) in year (Y), represented as a count variable ($CVC\ Deals_{i,Y}$). These data are collected from Thomson Reuters EIKON database. Each unique investment made in a startup company by a corporate investor between 2010-2017 in the panel is a count for one CVC deal in that particular year.

4.2.3 Moderating variable: Investment stage

When investing corporate venture capital, an important aspect to consider is the startup's development stage. Thomson Reuters' EIKON database reports investment stages for every unique investment in the databank. Corporate investors have either invested in startups at the seed, early, expansion or late stage. The corresponding investment stage is directly related to different levels of uncertainty. The more mature the investment stage, the further developed are the startups' processes and the less uncertainty is involved in the investment (Matusik & Fitza, 2012). Sources of uncertainty may include a lack of knowledge with regards to new technologies, markets or consumer acceptance or a lack of specific skills needed to use the technology (Gladstone & Gladstone, 2004). To operationalize the variable investment stage, the approach by Matusik & Fitza (2012) has been adopted. Each investment in 2010-2017 for every corporate investor (i) in year (Y) is categorized in a mutually exclusive group (seed, early, expansion and late stage). These categories are treated as an ordinal scale reaching from 1 - seed to 4 - late stage. Afterwards, an average per year has been calculated, indicating the preferred development stage a CVC firm invests in each year. This builds the foundation for the variable ($INV_{i,Y}$).

(1) Low investment stage: Seed stage
(2) Moderate investment stage: Early stage
(3) Advanced investment stage: Expansion stage
(4) Very high investment stage: Late stage

4.2.4 Moderating variable: Geographic proximity

Another variable considered in this study is geographic proximity. More specifically, geographic proximity measures the distance between the corporate investor and the investment target. Spatial distance is considered a fundamental factor influencing knowledge spillovers between corporates and startups (Howells, 2002). Thomson Reuters EIKON database provides information about the startup's and the corporate investor's country of origin. This information is augmented and matched with the continent of origin of both parties involved in the deal. Every investment from 2010-2017 received a different category of geographic proximity. The values are treated as an ordinal scale reaching from 1 - low proximity to 3 - high proximity of the investment. Based on this input an average score for each corporate investor (i) at year (Y) has been computed, creating the variable ($GEO_{i,Y}$).

(1) Low Proximity: Corporate investment in a different continent
(2) Moderate proximity: Corporate investment in the same continent but different country
(3) High proximity: Corporate investment in the same country

4.2.5 Control variables

To reduce omitted variable bias, a number of control variables have been included in the model. In this regard, the approaches of Chemmanur, Loutskina and Tian (2012) and Maula, Keil and Zahra (2013) were adopted, who identified a variety of control variables, influencing innovation beyond CVC investments. The control variables incorporated into the analysis are profitability ($ROA_{i,Y}$), firm size ($SIZE_{i,Y}$) and R&D intensity ($R\&D\ Intensity_{i,Y}$). First, the model controls for the profitability of firms. Highly profitable companies are assumed to possess more financial means to invest in innovation, which may positively influence patenting activity (Chemmanur, Loutskina and Tian, 2012). Profitability is measured by return on assets ($ROA_{i,Y}$) of the corporate investor (i) at year (Y). Second, the model controls for the firm size of the corporate investor. Larger corporations are assumed to have more resources and experience in their innovation process (Dushnitsky & Lenox, 2005). Firm size ($SIZE_{i,Y}$) is measured by the total assets of the corporate investor (i) at year (Y). Last, the model controls for R&D intensity. This variable ($R\&D\ Intensity_{i,Y}$) captures the corporate investor's internal innovation focus, as it weights how much a firm is willing to invest in innovation and technology-related issues (Maula, Keil and Zahra, 2013). R&D intensity is measured as the research and development expenditures to sales ratio of each corporate investor (i) at year (Y). Instead of including R&D expenditures as euro amount, this relative measure separates R&D effects from company size effects (Maula, Keil & Zahra, 2013). A detailed overview of the variables can be found in appendix A (table 5).

4.3 Research design

To test the hypotheses of the research, a panel data regression analysis is conducted. The dependent variable ($PAT_{i,Y+1}$) is a count variable, takes non-negative integers and does not follow a normal distribution. In order to address the discrete nature of the dependent variable, two regression types are commonly used in the empirical literature: Poisson regressions or negative binomial regressions. While a Poisson regression requires an index of dispersion equal to 1 for the dependent variable (Lawless, 1987; Lee et. al., 2011), a negative binomial regression assumes the variation of the count variables to be greater than of a true Poisson. Thus, the first step in this study is to test which of the two models better fits the data. A likelihood ratio test is employed to determine whether the patent count variable suffers from overdispersion. Hinde & Demetrio (1998) argue that failing to account for overdispersion underestimates the standard error and leads to erroneous inferences of the regression parameters. In the likelihood ratio test, the null hypothesis states that the dependent variable is constantly dispersed. The alternative hypothesis states that the dependent variable is overdispersed. Having conducted the test at a 5% significance level, it was found that the null hypothesis can be rejected ($p<0.0001$) (table 6, appendix B). Consequently, it can be confidently stated that the dependent variable suffers from overdispersion and that the Poisson regression assumption does not hold true for the observed data. Hausman, Hall, & Griliches (1984) argue that in case of an overdispersed dependent count variable, a negative binomial regression, which follows a gamma distribution, is the commonly used method to avoid heteroskedasticity problems. A negative binomial regression adds an individual, unobserved effect to the conditional mean (Dushnitsky & Lenox, 2005). Furthermore, this method is widespread in empirical studies with patent counts as dependent variables (Hausman, Hall, & Griliches, 1984; Graves & Langowitz, 1993; Dushnitsky & Lenox, 2005, Henderson & Cockburn, 1996).

Arellano (2009) outlines that the advantage of applying a negative binomial regression is the possibility to account for unobserved heterogeneity. This unobserved time-invariant heterogeneity may come from differences in firm characteristics or from yearly variations of the data, which further influence the response variable. The most common way to account for this is to control for fixed or random effects. While in fixed effects models, the error term is allowed to be correlated with the observed variables, in random effects models the unobserved variables are assumed not to be associated with the observed variables (Williams, 2018). To investigate which model better fits the data, a Hausman test was conducted (Hausman, Hall, & Griliches, 1984). As the Hausman test was significant at a 5% significance level ($p<0.0001$) (table 7, appendix C), a fixed effect negative binomial regression seems to be the appropriate model for this research.

More specifically, as the dataset includes multiple different publicly listed companies over an eight-year time period, the findings of the research may be subject to further unobserved heterogeneity bias. This bias may be linked to macroeconomic factors, to periods of technological ferment (Klevorick et al., 1995) or to differences in firm characteristics (Dushnitsky & Lenox, 2005), influencing the dependent variable. This analysis aims to reduce the bias by controlling for year and firm fixed effects. Firstly, year fixed effects control for yearly variation of patent application rates as well as macroeconomic issues, such as economic downturns. Thus, year dummies are added to the model to control for systematic time period effects (Nadkarni & Chen, 2014). Secondly, the model controls for unobserved, time-invariant differences in firm characteristics that may impact patenting activity.

Furthermore, as stated above, the research assumes a one-year time lag between the explanatory variables and the response variable. Following the approach from various authors, the relationship between the values of the independent variables in year (Y) is compared to the patent applications in year (Y+1) (Dushnitsky & Lenox, 2005; Wadhwa & Kotha, 2006; Hall & Zedonis, 2001). Moreover, Nadkarni & Chen (2014) argue that including a lagged effect also provides more evidence for the causality of the relationship. As learning effects of due diligences might occur immediately, knowledge transfers from holding board seats and learnings from venture failings may take some time. Moreover, the administrative time between the investment and the actual patent application is another reason to incorporate the time lag. To summarize, a positive effect of CVC deals is assumed to emerge in the year after the investment has taken place.

The following fixed-effect negative binomial regression model is employed with firm and year fixed effects. The expected number of patent applications given for the explanatory variables in the fixed effect model may be given by:

$$\mathrm{E}[PAT_{i,Y+1} \mid X_{i,Y}] = \lambda_{i,Y+1} = \exp\left(\beta X_{i,Y} + \epsilon_{i,Y} + \nu_i\right)$$

where, $X_{i,Y}$ are time variant regressors, β is the coefficient, $\epsilon_{i,Y}$ is the idiosyncratic (time variant) error term for corporate investors (i) at year (Y) and ν_i is the fixed effect (corporate investor time invariant) error term.

More specifically, the following regression equation is estimated by this analysis.

$$PAT_{i,Y+1} = \exp[\,\beta_0 + \beta_1 * CVC\ Deals_{i,Y} + \beta_2 * GEO_{i,Y} + \beta_3 * GEO_{i,Y} * CVC\ Deals_{i,Y} + \beta_4 * INV_{i,Y} + \beta_5 * INV_{i,Y} * CVC\ Deals_{i,Y} + \beta_6 * SIZE_{i,Y} + \beta_7 * ROA_{i,Y} + \beta_8 * R\&D\ Intensity_{i,Y} + \varepsilon_{i,Y} + \nu_i]$$

5. Analysis and Results

This chapter includes the empirical analysis of the results. First, descriptive statistics and correlations are presented. Second, the outcomes of the fixed effects negative binomial regression are discussed and an analysis of the magnitude of the variables in the regression is shown. For this purpose, marginal effects are presented using incidence rate ratios (IRR). Furthermore, the hypotheses drawn from the literature are analyzed for significance. For all tests, Stata 14 has been used as a statistical software tool.

5.1 Descriptive statistics

Table 1 presents some definitions and descriptive statistics. It contains an overview of the different variables included in this research. From table 1, it can be observed that corporate investors in the sample applied on average for 1,024.25 patents per year. The maximum number of patents applied for in one year is 10,165 in the year 2014 by Qualcomm, a multinational corporation from the US. Moreover, it can be seen that the dependent variable's ($PAT_{i,Y+1}$) standard deviation (1,783.69) is larger than its mean (1,024.25). This provides further evidence that the dependent variable is overdispersed and employing a negative binomial regression is the appropriate model of analysis. On average, investors in the sample engaged in 6.24 corporate venture capital deals per year indicating that corporate investors put significant attention and financial means into external knowledge generation through CVC. Moreover, the mean score for investment stages is 2.8. Compared to the scale midpoint of 2.5, it shows that on average the corporate investors in the sample prefer investments at a rather later stage. In respect to geographic proximity, the mean in the sample is 2.25. Compared to the scale midpoint of 2, it indicates that the corporate investors in the dataset invest on average in startups that are rather close to them.

The mean for the profitability measure used in this paper ($ROA_{i,Y}$) is 8.7%, varying from -23.9% to 31.9%. This shows that some corporate investors in the sample have not been profitable during the entire time span of the sample. The mean of total assets of the firms in the sample is €83.27bn and ranges from €1.08bn to €748bn. The highest number of total assets in the dataset (€748bn) belongs to General Electric, an American conglomerate in 2010. On average, the corporate investors in the sample have an R&D intensity of 11.4%, showing that in addition to CVC, they also invest significant amounts of their sales back in R&D to drive innovation.

Table 1: Descriptive statistics

Variable	Description	Mean	Std. Dev.	Min	Max
PAT	Number of patent applications by a firm in year Y+1	1024.25	1783.69	1	10165
CVC Deals	Number of CVC investments by a firm in year Y	6.236	9.539	1	66
INV	Average investment stage score ranging from 1-4 in year Y	2.797	.666	1	4
GEO	Average geographic proximity score ranging from 1-3 in year Y	2.254	.759	1	3
ROA	Net income to total assets ratio in year Y	.087	.064	-.239	.319
SIZE	Total assets of a firm in €Bn in year Y	83.27	100.17	1.077	747.79
R&D Intensity	R&D expenditures to sales ratio in year Y	.114	.138	0	1.227

5.2 Correlations

The correlation matrix for all seven variables included in the analysis is presented in table 2 below. The correlation values of the predictor variables lie between -0.264 and +0.236. As these correlations are not very high, it can be assumed that multicollinearity is not an issue in this study. From table 2, a negative correlation between R&D intensity and firm size can be observed. This suggests that smaller firms in the sample have a relatively higher R&D to sales ratio, compared to larger firm. Furthermore, CVC deals are positively correlated to the corporate investor's innovativeness with a correlation coefficient of 0.506. This result gives a first indication that the two variables are somehow related to each other. However, this information only emphasizes a co-movement of the two variables and does not tell anything about the cause and effect as well as the magnitude of the relationship. Therefore, a panel regression analysis should provide further exploration of the relationship.

Additionally, drawing from the correlation matrix (table 2), it seems that all three control variables, $ROA_{i,Y}$, $SIZE_{i,Y}$ and $R\&D\ Intensity_{i,Y}$ are related to the investor's innovativeness. Therefore, it seems reasonable to control for all three factors in the regression model to receive more meaningful results for the other variables.

Table 2: Matrix of correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) PAT $_{Y+1}$	1.000						
(2) CVC Deals $_{Y}$	.506***	1.000					
(3) INV $_{Y}$	.133**	-.043	1.000				
(4) GEO $_{Y}$	-.092*	.101**	-.104**	1.000			
(5) ROA $_{Y}$	.171***	.236***	-.088*	.014	1.000		
(6) SIZE $_{Y}$	.277***	.068**	.144**	.039	-.189***	1.000	
(7) R&D Intensity $_{Y}$	.063*	.080*	-.137***	-.039	.060*	-.264***	1.000

**** p<0.01, ** p<0.05, * p<0.1*

5.3 Multivariate analysis

For this research, a fixed effect negative binomial regression is used to test and assess the relationships between the variables. Following the approach of existing theory, four models are introduced sequentially to better understand the different effects of the variables on the dependent variable (Lee & Kang, 2015; Dushnitsky & Lenox, 2005, Wadhwa & Kotha, 2006). All four models account for firm fixed effects and include year dummies. A summary of the regression results can be found in table 3 below. Wald Chi^2 tests are used to check for the robustness of the models. All four models of this study are significant at a 1% significance level and have high Wald Chi^2 scores of above 550, suggesting an overall good model fit. A more detailed and individual overview of the regression models can be found in appendix D (tables 8-11). To analyze the magnitude of the effect of the explanatory variables on the response variable, this study follows the approach of the existing literature and conducts an effect analysis using incidence rate ratios (Siegel, Ross & King, 2013). This approach is confirmed by Buis (2019) and Piza (2012), who state that for non-linear models, incidence rate ratios are a commonly used approach to analyze the effect of the independent on the dependent variable.

The first model of this research is the basic model, in which only the three control variables ($ROA_{i,Y}$, $SIZE_{i,Y}$ and $R\&D\ Intensity_{i,Y}$) are included. This provides an overview of how the control variables impact the dependent variable and why it may be important to include them in the model. While the second model adds the main independent variable ($CVC\ Deals_{i,Y}$) to the regression equation, model 3 introduces the first moderating variable to the model. Thus, for model 3, two additional variables are added, including investment stage ($INV_{i,Y}$) and the interaction term between CVC deals and investment stage ($INV_{i,Y} * CVC\ Deals_{i,Y}$). The last additions are the independent variables geographic proximity ($GEO_{i,Y}$) and the respective interaction term ($GEO_{i,Y} * CVC\ Deals_{i,Y}$), representing model 4.

Model 1 shows that an investor's R&D intensity (β=0.901, $p<0.01$) and firm size (β=0.00158, $p<0.01$) are positively related to the investor's innovativeness. Both variables are significant at a 1% significant level. This is in line with existing research stating that larger firms have a higher innovation output, compared to smaller firms (Chemmanur, Loutskina & Tian, 2012; Maula, Keil & Zahra, 2013). This seems reasonable, as larger firms have potentially more resources to dedicate to innovation and usually possess more experience. Moreover, large firms seem to realize that innovation is key to maintain their strong market position, which is why they invest many resources to generate innovation.

Table 3: Fixed effects negative binomial regression

Variables	Model 1	Model 2	Model 3	Model 4
Constant	0.507*** (0.11)	0.860*** (0.12)	0.736*** (0.15)	0.848*** (0.18)
R&D Intensity	0.901*** (0.26)	0.881*** (0.23)	0.837*** (0.23)	0.828*** (0.23)
SIZE	0.00158*** (0.00)	0.0099** (0.00)	0.0089** (0.00)	0.0090** (0.00)
ROA	0.516 (0.37)	0.434 (0.39)	0.546 (0.39)	0.557 (0.40)
CVC Deals		0.007** (0.00)	0.031** (0.01)	0.034 (0.02)
INV			0.053* (0.03)	0.048 (0.03)
INV ∗ CVC Deals			-0.009* (0.005)	-0.009* (0.01)
GEO				-0.042 (0.04)
GEO ∗ CVC Deals				-0.001 (0.01)
Firm Effects	fixed	fixed	fixed	fixed
Year Effects	yes	yes	yes	yes
Observations[1]	511	419	413	413
Firms	66	66	66	66
Log Likelihood	-2761.5635	-2153.6607	-2124.4765	-2123.5838
Wald Chi^2	604.77***	607.03***	562.38***	567.36***
Prob > Chi^2	0.0000	0.0000	0.0000	0.0000

Standard errors in parentheses

[1]Sample size decreases due to missing values

**** p<0.01, ** p<0.05, * p<0.1*

Yet, this does not mean that larger firms are more innovative in general, as it does not show whether large firms have a higher ratio of innovation output to firm size. However, as firm size differences exist, it is important to control for them. Furthermore, companies investing significant shares of their sales back in R&D as a source of internal knowledge generation have higher patenting activity and are considered to be more innovative than companies that have lower R&D to sales ratios. This is in line with existing literature arguing that investments in R&D increase the knowledge stock of a firm and impact the innovativeness of the firm (Hausman, Hall, & Griliches, 1984). Finally, this analysis does not find a detectable effect of profitability, measured in terms of return on assets, on the corporate investor's innovativeness. It seems that profitability by itself does not directly influence innovation output. For the other three models, model 2-4, similar results are found for the control variables. The control variables are added to the model to separate their effects from CVC deals on the dependent variable, so that a better understanding of the relationship of the other variables can be developed.

In model 2, the main independent variable ($CVC\ Deals_{i,Y}$) is introduced, which builds the foundation for the analysis of hypothesis 1. As previously outlined, hypothesis 1 states that CVC deals are positively related to the investor's innovativeness. Given the result table 3, it can be confidently stated that CVC deals (β=0.007, $p<0.05$) are positively related to the number of patent applications. Hypothesis 1 is supported at a 5% significance level. Thus, external knowledge acquisition through corporate venture capital significantly enhances the innovativeness of the investor. Through access to startup knowledge, corporate investors are able to receive various insights into different new markets and technologies. Investors are able to use and incorporate this knowledge and combine it with internally generated R&D knowledge to drive innovation. Furthermore, it seems that corporate investors are able to better process the knowledge and transform it into innovation output in terms of patent applications. Conducting the effect analysis with incidence rate ratios using Stata, the magnitude of this relationship can be seen in appendix E (table 12). This study finds that for every additional CVC deal, the innovativeness of the corporate investor increases by 3.44%.

The third model of the research adds the first moderating variable, investment stage ($INV_{i,Y}$) and the interaction variable ($INV_{i,Y} * CVC\ Deals_{i,Y}$), to the regression equation. Hypothesis 2 states that the earlier the investment stage of the startup, the higher is the positive effect of CVC deals on the innovativeness of the investor. As table 3 shows, the interaction term of investment stage and CVC deal has indeed a significant negative impact (β= -0.009, $p<0.1$) on the positive relationship of CVC deals and the innovator's innovativeness. Hypothesis 2 is supported at a

10% significance level. Therefore, it can be stated that, as the phase of development of the investment target becomes more mature, the impact on CVC deals on the investor's innovativeness decreases. It seems that knowledge acquired from more mature startups does not provide as much value to the corporate investor as the knowledge generated from startups in earlier development stages. Thus, it seems that the knowledge gathered is not as disruptive and radical, compared to seed or early stage startups and therefore, less innovation output is created. The effect analysis using incidence rate ratios shows that for an increase in one scale point on the ordinary scale, the relationship of CVC deals and the investor's innovativeness decreases by 0.90% for one additional CVC deal. Thus, it can be stated that when assuming an increase of one point on the investment stage ordinary scale, the impact of CVC investments on the corporate investor's innovativeness decreases from 3.44% to 2.54%. This indicates a significant negative impact of investment stage with increasing maturity on the relationship between CVC and the investor's innovativeness.

The last model of this study examines the full model, which includes all variables. Hypothesis 3 proposes a positive moderating relationship of geographic proximity on the relationship between CVC and the investor's innovativeness, meaning that the closer the corporate investor is to the startup, the stronger the positive relationship between CVC and the corporate investor's innovativeness. From table 3, it can be observed that this research did not find a significant moderating effect of geographic proximity on the relationship between CVC and patent applications, as the coefficients are not significant. Thus, hypothesis 3 is not supported and no direct interpretation can be drawn from these variables. However, it seems that geographic proximity does not majorly influence the strength of the relationship between CVC deals and the corporate investor's innovativeness. Table 4 below provides an additional overview of the hypotheses and the results of this study.

Table 4: Summary of hypothesized relationships

Hypotheses	**Results**
H1: *There is a positive relationship between corporate venture capital investments and the investor's innovativeness.*	Supported
H2: *The relationship between corporate venture capital investments and the investor's innovativeness is moderated by investment stage. That is, the earlier the investment stage, the higher the positive effect of the corporate venture capital investments on the investor's innovativeness.*	Supported
H3: *The relationship between corporate venture capital investments and the corporation's innovativeness is moderated by geographic proximity. That is, the closer the investor is to the investment receiving firm, the stronger the positive effect of the corporate venture capital investment on the investor's innovativeness.*	Not Supported

6. Discussion and Managerial Implications

This chapter summarizes the main findings of the research and outlines the theoretical contribution to the empirical literature. This study extends the existing literature in fields of corporate entrepreneurship, knowledge-based view theory and real options theory. Furthermore, managerial implications are presented to provide practical guidance to managers for future corporate venture capital programs.

6.1 Theoretical contribution

This paper aims to analyze the impact and magnitude of corporate venture capital investments on the corporate investor’s innovativeness and explores circumstances that influence this relationship. Furthermore, guidance to practitioners is given, so that managers are able to adjust their future actions accordingly. These topics are of utmost importance for many corporations, as incumbents increasingly seek to access new and disruptive knowledge to drive innovation and to maintain their competitive position (Chesbrough & Tucci, 2002). Moreover, existing gaps in the literature with regards to geographic proximity (Howells, 2002; Morgan, 2004; Boschma, 2005) and the optimal investment stage (Yang, Narayanan & Zahra, 2009; Keil, Zahra & Maula, 2004, Wadhwa, Phelps & Kotha, 2010; Matusik & Fitza, 2012) are analyzed and three hypotheses are drawn from the theory. Thus, this paper contributes to the empirical literature by filling these gaps and by shedding light on the theoretical controversies outlined in chapter 3 of this study. Specifically, the proposed relationships between variables are tested using a panel dataset, containing 66 corporate investors with more than 400 observations. A negative binomial regression with fixed effects is employed to find empirical evidence for the relationships.

This study supports the results of Dushnitsky and Lenox (2005) by finding a significant positive relationship between CVC deals in year (Y) and patent applications in year (Y+1). This finding augments the existing literature of the knowledge-based view theory because it confirms the importance of knowledge as a strategic resource, leading to more innovation activities within firms. It provides evidence that gathering knowledge from external entrepreneurial ventures significantly impacts the innovation outputs of corporate investors and shows that CVC programs play a significant role in successfully driving innovation. This paper found that for every additional CVC deal, the investor’s patent application rate increases by

3.44%. However, although a significant result for the impact of corporate venture capital deals on the investor's innovativeness is found, the effect seems to be fairly small. This rather small effect might exist due to the fact that other external and internal knowledge generation means, such as strategic alliances, joint ventures, R&D alliances or other M&A activities also impact the patenting activities of incumbents (De Man & Duysters, 2005). Additionally, not all innovation activities occurring in firms through CVC are patented (Fontana et al., 2013). Thus, this study may underestimate the actual effect of CVC on the innovation activities within firms. Furthermore, patent applications are considered to be rather expensive innovation outputs, as they are subject to significant patent filing fees, which reduce the motivation to apply for patents (European Commission, 2015).

Nevertheless, it seems that through the access of startup knowledge via CVC investments, corporations are able to bring disruptive technological and market knowledge into the firm (Chesbrough & Tucci, 2002) and strengthen the corporate investors' dynamic capabilities. The newly acquired knowledge is often used and combined with internal knowledge from R&D departments in order to build new innovative solutions (Sahaym, Steensma & Barden, 2010). Companies need to realize that the constant renewing and increase of knowledge stock is a fundamental factor to enhance innovation activities, which can ultimately lead to a sustained competitive advantage (Kogut & Zander, 1992). Overall, this finding highlights the strategic importance of CVC programs to incumbents, emphasizing that such programs seem to be beneficial to companies to improve their innovation strategies.

Moreover, this research adds to the existing corporate entrepreneurship literature by providing a more detailed investigation of circumstances that shape the relationship between corporate venture capital and the investor's innovativeness. Specifically, this research examines the effect of investment stages and geographic proximity on this relationship. A negative moderating effect of investment stage maturity on the relationship of CVC and the investor's innovativeness is detected. This study finds empirical evidence that the relationship between CVC and the corporate investor's innovativeness is stronger when investing in rather early stage startups. This finding contributes to the real options theory, as although early stage startups are associated with more uncertainty, the relationship between CVC on the corporate investor's innovativeness is found stronger, the earlier the development stage of the startup. Although late stage startups are associated with less technological and market uncertainty for the corporate investor, as some milestones have already been achieved (Wadhwa, Phelps & Kotha, 2010), it seems that corporate investors benefit less from the acquired knowledge from startups in late development stages. This highlights that the nature of early stage CVC deals as being limited commitments to uncertain technologies does not hinder but promotes the success of CVC investments. It seems that the value of a real option to adjust resource commitments when necessary at a later stage, significantly impacts the relationship between CVC and the innovativeness of the corporate investor. Therefore, companies seem to benefit when investing in early startups with the potential option to invest further in the future, as it reduces downside risk, while preserving upside opportunity (Kogut & Kulatilaka, 2001). Furthermore, this study contributes to the corporate entrepreneurship literature because it provides evidence for the magnitude of the relationships. This paper found that for one additional score point on the ordinal investment stage scale towards more stage maturity, the relationship between CVC deals and the investor's innovativeness decreases by 0.9% from 3.44% to 2.54%.

Lastly, this study further contributes to the corporate entrepreneurship literature and to the knowledge-based view theory by assessing the influence of geographic proximity on the relationship between CVC and the investor's innovativeness. Hypothesis 3 suggests a positive effect of geographic proximity on the relationship of CVC and the corporate investor's innovativeness, as knowledge transfer is assumed to be facilitated when the distance is minimized (Howells, 2002; Morgan, 2004). It was argued that especially tacit knowledge can be easier transmitted when the corporate investor's location is close to the venture. However, this paper does not find empirical support for hypothesis 3. It seems that the geographic distance does not play a fundamental role in impacting the relationship between CVC and the investor's innovation rate. This is in line with the authors arguing in favor of the "death of geography" theory (Han, Tsou & Clarke, 2017). It seems that companies are not constrained to source knowledge only from startups, which are closely located to the investor but are encouraged to source knowledge worldwide and use different kinds of communication technology as tools to ensure a smooth knowledge transfer.

6.2 Managerial implications

The findings of the research provide many valuable insights for managers and practitioners in the real-world economy. As corporate managers decide how to best allocate resources, CVC programs need to become part of corporations' innovation roadmaps and corporate strategies. As corporate venture capital investments significantly increase the investor's innovation rate and complement internal R&D activities, it becomes more and more important to use CVC as a tool to maintain a competitive market position. Managers should construct CVC programs inside their firms, which do not only provide financing to startups and negotiate the investment terms but also ensure a successful knowledge transfer from the venture into the firm. New business functions should be established with a main focus on the incorporation of external knowledge into the firm. Furthermore, the corporate investors should select managers to take board seats in the invested startups and participate in management meetings to be able to better understand the startup's technologies as well as its day-to-day business and operations.

Moreover, when it comes to the selection of startups that fit the parent company, this research finds evidence that managers should target startups in a rather early stage of development. As this study finds a negative moderating effect of mature investments on the relationship of CVC and the investor's innovation rate, knowledge from startups in earlier stages seems to be more disruptive and newer to the market, ultimately leading to more innovation activity for the corporate investor. To be able to fully exploit the value of real options, managers should formulate contracts with startups using series financing, also called investment staging. Series A, B or C financing is one way for corporate investors to grow and develop startups by means of outside investments. In this case, financing should be provided in successive rounds of investment and should be aligned with different milestone achievements (Hill et al., 2009). This procedure offers a lot of upside potential, while minimizing downside risk, as a corporate investor can only lose the money up to the previous investment. Furthermore, scaling potential is virtually unlimited. Following startups through series financing, such as A, B and C should be a main goal of managers and should be incorporated in their corporate strategies. This is in line with Hill et al. (2009), who found a positive relationship between investment staging and CV unit performance.

7. Limitations and Future Research

Although the research was designed to optimize the meaningfulness of the statistical results, some limitations should be listed. First, this paper takes the number of patent applications as a proxy for innovation. This comes with four main limitations. First, the yearly patent output of a firm does not fully reflect the entire knowledge flow from a startup to an investor (Wadhwa & Kotha, 2006). Patent counts only capture the codified proportion of knowledge transfer and does not distinguish between exploitative innovation and explorative innovation. Furthermore, not all patent applications are granted in a later stage and can, therefore, be considered a proper patent or innovation ("new combinations of new or existing knowledge") (Schumpeter, 1934, p.65), as it might have already existed. However, it does represent the effort of combining new knowledge and create some kind of tangible output, which is why this research has used it as proxy for innovation. Second, as patent applications only measure innovation output, they do not tell anything about the quality of the patent. Some highly valued patents are worth more, compared to some patents that are not as relevant for companies. To account for this, other researchers have used the number of patents cited to give an indication of the importance of the patent and to be able to mitigate this issue. However, Hagedoorn & Cloodt (2003) outline that both proxies for firm innovativeness are equally feasible to use in the scientific literature, as patent citations and patent counts are highly correlated. Third, not all innovations occurring within a company are patented (Fontana et al., 2013). Some of the innovation activities occurring in firms are not patented, as it might be very hard to copy by competitors or might be given to the public to solve a deeper societal issue. Last, the propensity of patents usually varies from year to year and from firm to firm. Macroeconomic differences in different years as well as firm individual characteristics may impact patenting activity. To reduce this bias, year and firm fixed effects have been included in this study (Wadhwa, Phelps & Kotha, 2016). Future research can try to replicate the findings of this paper, using different proxies for innovation, such as new product announcements or the number of patents cited. This would augment the academic literature with further clarity and a better understanding of the relationship between corporate venture capital and innovation. Additionally, it would provide more robustness to the findings of this research.

Although this study accounts for differences in firm characteristics and differences in year effects, it does not account for unobserved heterogeneity with regard to differences between startups. The quality and success of the target investments have not been measured, which may also influence the innovation rate of the corporate investor. Future research can further specify and dig deeper into the differences in startup quality and may determine specific startup characteristics, leading to more innovation activity for the corporate investor.

Contrarily to other researches (Henderson, 1993; Tushman & Anderson, 1986; Wadhwa, Phelps & Kotha, 2016), this study has not followed a particular industry-focused approach to be able to find more generalized connections across industries and to have a more complete dataset. However, this reduces the robustness of the analysis, as this study does not account for the unobserved heterogeneity with regards to industry differences (Wadhwa, Phelps & Kotha, 2016). Future research should do so and account for differences in industry characteristics by exploring many different industry types in order to find further proof of the positive relationship between CVC and the corporate investor's innovativeness.

Although this study measured the impact of CVC deals and other independent variables on firm's innovation output, it is not clear whether the higher innovation output is beneficial to firms or worth the investment. Therefore, future research should test whether the increase in innovation activities enhance the overall firm performances (e.g. measured by EBITDA margins) 2-3 years after the patents have been filed.

8. Conclusion

The ability to constantly innovate is one of the most crucial determinants for the long-term survival of incumbents and can build the foundation for a competitive advantage (Schumpeter, 1934). To ensure continuous innovation, firms should regularly renew and extent their knowledge stock. This study sheds light on one significant tool how new and external knowledge can be sourced, leading to more innovation activity. In particular, an analysis of the effect of corporate venture capital deals on the patent application rate of large publicly listed firms has been conducted. This study finds empirical evidence for a positive relationship between corporate venture capital and the corporate investor's innovativeness. Furthermore, this research shows that the effect of the relationship between CVC and patents is greater when investing in rather early stage startups. The specific knowledge that is accessed via early stage investments is more disruptive and newer to the market and thus, provides more value for incumbents. Managers can utilize this study to adapt their established CVC programs or even construct a new and sophisticated CVC unit within their firms.

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10. Appendices

Appendix A: Overview of variables of the study

Table 5: Detailed variable overview

Type of Variable	**Name of Variable**	**Measure**	**Unit**	**Data Collection Database**
Dependent variable	$\mathrm{Pat}_{\mathrm{i,Y+1}}$	Patents	Unit Count	PatStat
Independent variable	$CVC\ Deals_{\mathrm{i,Y}}$	Number of CVC Investments	Unit Count	Thomson Reuters EIKON
Moderating variable	$INV_{\mathrm{i,Y}}$	Investment Stage	Scale 1-4	Thomson Reuters EIKON
Moderating variable	$GEO_{\mathrm{i,Y}}$	Geographic Proximity	Scale 1-3	Thomson Reuters EIKON
Control variable	$ROA_{\mathrm{i,Y}}$	Return on Assets	%	Orbis
Control variable	$SIZE_{\mathrm{i,Y}}$	Total Assets	In €Bn	Orbis
Control variable	$R\&D\ Intensity_{\mathrm{i,Y}}$	Research & Development Expenses to Sales ratio	%	Orbis

Appendix B: Outcomes of the likelihood-ratio test for overdispersion

Table 6: Likelihood-ratio test for overdispersion

PAT	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
CVC Deals	0.050	0.007	6.76	0.000	0.035	0.064	***
Constant	6.524	0.075	86.92	0.000	6.377	6.671	***
/lnalpha	0.570	0.053	.b	.b	0.466	0.674	

Mean dependent var	1073.163	SD dependent var	1876.781
Pseudo r-squared	0.010	Number of obs	498.000
Chi-square	77.869	Prob > chi2	0.000
Akaike crit. (AIC)	7672.717	Bayesian crit. (BIC)	7685.349

Likelihood-ratio test of alpha=0: chibar2(01) = 7.9e+05 Prob>=chibar2 = 0.000

**** p<0.01, ** p<0.05, * p<0.1*

Appendix C: Outcomes of the Hausman Specification Test

Table 7: Hausman (1978) specification test

	---- Coefficients ----			
	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
	fixed	random	Difference	S.E.
CVC Deals	0.034	0.033	0.001067	0.0043536
INV	0.048	0.043	0.005168	0.0041378
INV*CVCDeals	-0.009	-0.009	-0.000411	0.0011647
GEO	-0.042	-0.037	-0.005073	0.0045596
GEO*CVCDeals	-0.001	-0.001	-0.000278	0.0010579
ROA	0.557	0.612	-0.054940	0.0563768
R&D Intensity	0.828	0.937	-0.108790	0.0813359
SIZE	0.001	0.001	-0.000143	0.0001418
YearDum1	1.717	1.724	-0.006363	0.012457
YearDum2	1.667	1.673	-0.005760	0.0122925
YearDum3	1.671	1.675	-0.004430	0.0116217
YearDum4	1.597	1.597	0.000062	0.0109373
YearDum5	1.518	1.520	-0.001648	0.0111908
YearDum6	1.432	1.435	-0.003175	0.0115711
YearDum7	0.998	1.004	-0.006310	0.012148

b = consistent under Ho and Ha; obtained from xtnbreg
B = inconsistent under Ha, efficient under Ho; obtained from xtnbreg

Test: Ho: difference in coefficients not systematic

chi2(15) = (b-B)'[(V_b-V_B)^(-1)](b-B)

= 329.96

Prob>chi2 = 0.0000

Appendix D: Model Specification - FE negative binomial regression

Table 8: Model 1 - Conditional FE negative binomial regression

PAT	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
ROA	0.516	0.371	1.39	0.164	-0.211	1.244	
R&D Intensity	0.901	0.256	3.52	0.000	0.400	1.402	***
SIZE	0.002	0.000	4.39	0.000	0.001	0.002	***
YearDum1	1.682	0.087	19.37	0.000	1.512	1.852	***
YearDum2	1.699	0.087	19.61	0.000	1.529	1.869	***
YearDum3	1.710	0.086	19.84	0.000	1.541	1.879	***
YearDum4	1.613	0.087	18.53	0.000	1.442	1.784	***
YearDum5	1.519	0.088	17.26	0.000	1.346	1.691	***
YearDum6	1.400	0.089	15.77	0.000	1.226	1.574	***
YearDum7	0.977	0.093	10.53	0.000	0.795	1.158	***
YearDum8	0.000	.	.	.	.	.	
Constant	0.507	0.114	4.45	0.000	0.284	0.730	***

Mean dependent var	1114.360	SD dependent var	1829.842
Number of obs	511.000	Chi-square	604.773
Prob > chi2	0.000	Akaike crit. (AIC)	5545.127

**** $p<0.01$, ** $p<0.05$, * $p<0.1$*

Table 9: Model 2 - Conditional FE negative binomial regression

PAT	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
CVC Deals	0.007	0.003	2.17	0.030	0.001	0.014	**
ROA	0.434	0.392	1.11	0.268	-0.334	1.202	
R&D Intensity	0.881	0.226	3.89	0.000	0.437	1.324	***
SIZE	0.001	0.000	2.36	0.018	0.000	0.002	**
YearDum1	1.705	0.085	19.98	0.000	1.538	1.872	***
YearDum2	1.668	0.085	19.54	0.000	1.500	1.835	***
YearDum3	1.678	0.083	20.11	0.000	1.515	1.842	***
YearDum4	1.599	0.084	19.13	0.000	1.435	1.762	***
YearDum5	1.527	0.083	18.39	0.000	1.364	1.690	***
YearDum6	1.437	0.084	17.08	0.000	1.272	1.602	***
YearDum7	1.009	0.088	11.46	0.000	0.837	1.182	***
YearDum8	0.000	.	.	.	.	.	
Constant	0.860	0.125	6.89	0.000	0.616	1.105	***

Mean dependent var	1170.506	SD dependent var	1930.167
Number of obs	419.000	Chi-square	607.029
Prob > chi2	0.000	Akaike crit. (AIC)	4331.321

**** p<0.01, ** p<0.05, * p<0.1*

Table 10: Model 3 - Conditional FE negative binomial regression

PAT	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
CVC Deals	0.031	0.014	2.30	0.021	0.005	0.058	**
INV	0.053	0.030	1.80	0.072	-0.005	0.111	*
INV*CVCDeals	-0.009	0.005	-1.78	0.074	-0.019	0.001	*
ROA	0.546	0.393	1.39	0.165	-0.224	1.317	
R&D Intensity	0.837	0.230	3.63	0.000	0.386	1.288	***
SIZE	0.001	0.000	2.07	0.039	0.000	0.002	**
YearDum1	1.707	0.091	18.74	0.000	1.528	1.885	***
YearDum2	1.657	0.090	18.37	0.000	1.480	1.833	***
YearDum3	1.668	0.088	18.93	0.000	1.496	1.841	***
YearDum4	1.588	0.088	18.04	0.000	1.415	1.760	***
YearDum5	1.516	0.087	17.37	0.000	1.345	1.687	***
YearDum6	1.428	0.088	16.26	0.000	1.256	1.600	***
YearDum7	0.997	0.092	10.88	0.000	0.817	1.176	***
YearDum8	0.000	.	.	.	.	.	
Constant	0.736	0.150	4.89	0.000	0.441	1.031	***

Mean dependent var	1186.722	SD dependent var	1939.427
Number of obs.	413.000	Chi-square	562.376
Prob > chi2	0.000	Akaike crit. (AIC)	4276.953

*** *p<0.01*, ** *p<0.05*, * *p<0.1*

Table 11: Model 4 - Conditional FE negative binomial regression

PAT	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
CVC Deals	0.034	0.024	1.43	0.153	-0.013	0.080	
INV	0.048	0.030	1.58	0.114	-0.011	0.107	
INV∗CVCDeals	-0.009	0.005	-1.72	0.085	-0.019	0.001	*
GEO	-0.042	0.037	-1.13	0.257	-0.115	0.031	
GEO∗CVCDeals	-0.001	0.006	-0.15	0.880	-0.012	0.011	
ROA	0.557	0.396	1.41	0.159	-0.218	1.332	
R&D Intensity	0.828	0.229	3.62	0.000	0.380	1.276	***
SIZE	0.001	0.000	2.10	0.036	0.000	0.002	**
YearDum1	1.717	0.092	18.75	0.000	1.538	1.897	***
YearDum2	1.667	0.091	18.41	0.000	1.490	1.845	***
YearDum3	1.671	0.088	18.95	0.000	1.498	1.843	***
YearDum4	1.597	0.088	18.08	0.000	1.424	1.770	***
YearDum5	1.518	0.087	17.38	0.000	1.347	1.689	***
YearDum6	1.432	0.088	16.30	0.000	1.260	1.604	***
YearDum7	0.998	0.092	10.90	0.000	0.819	1.177	***
YearDum8	0.000	.	.	.	.	.	
Constant	0.848	0.184	4.60	0.000	0.487	1.208	***

Mean dependent var	1186.722	SD dependent var	1939.427
Number of obs	413.000	Chi-square	567.355
Prob > chi2	0.000	Akaike crit. (AIC)	4279.168

**** p<0.01, ** p<0.05, * p<0.1*

Appendix E: Magnitude Analysis via Incident Rate Ratios

Table 12: Incidence rate ratios

PAT	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
CVC Deals	1.0344	0.024	1.43	0.153	0.988	1.083	
INV	1.0491	0.032	1.58	0.114	0.989	1.113	
INV∗CVCDeals	0.9910	0.005	-1.72	0.085	0.981	1.001	*
GEO	0.9587	0.036	-1.13	0.257	0.891	1.031	
GEO∗CVCDeals	0.9991	0.006	-0.15	0.880	0.988	1.011	
ROA	1.7452	0.690	1.41	0.159	0.804	3.790	
R&D Intensity	2.2892	0.523	3.62	0.000	1.463	3.583	***
SIZE	1.0009	0.000	2.10	0.036	1.000	1.002	**
YearDum1	5.5703	0.510	18.75	0.000	4.655	6.666	***
YearDum2	5.2966	0.480	18.41	0.000	4.435	6.325	***
YearDum3	5.3149	0.469	18.95	0.000	4.472	6.317	***
YearDum4	4.9367	0.436	18.08	0.000	4.152	5.870	***
YearDum5	4.5621	0.398	17.38	0.000	3.845	5.414	***
YearDum6	4.1870	0.368	16.30	0.000	3.525	4.974	***
YearDum7	2.7124	0.248	10.90	0.000	2.267	3.245	***
YearDum8	1.0000	.	.	.	.	.	
Constant	2.3338	0.430	4.60	0.000	1.627	3.348	***

Mean dependent var	1186.722	SD dependent var	1939.427
Number of obs	413.000	Chi-square	567.355
Prob > chi2	0.000	Akaike crit. (AIC)	4279.168

*** *p<0.01*, ** *p<0.05*, * *p<0.1*

Appendix F: Declaration of Originality MSc Thesis

By signing this statement, I hereby acknowledge the submitted MSc Thesis titled

"The Effect of Corporate Venture Capital Investments on the Investor's Innovativeness: The Moderating Role of Geographic Proximity and Investment Stage"

to be produced independently by me, without external help.

Wherever I paraphrase or cite literally, a reference to the original source (journal, book, report, internet, etc.) is provided.

By signing this statement, I explicitly declare that I am aware of the fraud sanctions as stated in the Education and Examination Regulations (EERs) of SBE, Maastricht University.

Place: Maastricht

Date: 18.12.2019

First and last name: Fabio Tomasetti

Study program: M.Sc. International Business – Strategy & Innovation

ID number: i6089742

Signature: